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## PATENT APPLICATION

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Sir:

Enclosed herewith for filing is the following **utility patent application**:

Applicant(s): **Donald F. Gordon, Christopher Goode,  
Edward A. Ludvig**

Title of application: **METHOD AND APPARATUS FOR PRODUCING  
DEMAND REAL-TIME TELEVISION**

Pages of specification: 20 (+ 5 pages of claims and 1 page abstract)

Sheets of drawing: 5

Executed on: November 24, 1998 Docket No.: **533/173**

### PATENT APPLICATION FILING FEE CALCULATION

	<u>No.</u>	<u>Filed</u>	<u>Less</u>	<u>Rate/Claim</u>	<u>Fee</u>
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Total Claims	24	-20	4	x \$ 9.00	\$ 36.00
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Independent Claims	3	-3	0	x \$39.00	\$ 0.00
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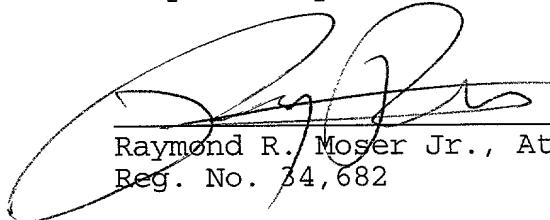
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- Oath;  
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 Disclosure Statement;  
 Letter referencing previously filed disclosure document; number \_\_\_\_\_ filed \_\_\_\_\_;  
 Verified Statement claiming small entity status;  
 An assignment of the application to: DIVA Systems Corporation;  
 Claim(s) to priority  
    Serial Number                  Filing date  
 A certified copy of a \_\_\_\_\_ patent application or inventor's certificate, filed \_\_\_\_\_ and serial no. \_\_\_\_\_, upon which a claim to priority is made;

Respectfully submitted,



11-30-98

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**METHOD AND APPARATUS FOR PRODUCING  
DEMAND REAL-TIME TELEVISION**

CROSS-REFERENCE TO A RELATED APPLICATION

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The disclosure contained in this application is related to U.S. patent application serial number \_\_\_\_\_ (attorney docket number 167), filed simultaneously herewith and herein incorporated by reference.

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BACKGROUND OF THE DISCLOSURE

1. Field of the Invention

The invention relates to video-on-demand systems and, 15 more particularly, the invention relates to a method and apparatus for generating a real-time video bitstream for transmission through a video-on-demand system as well as simultaneously storing the video information in a format that facilitates demand television, i.e., a play bitstream, 20 a fast forward bitstream and a fast reverse bitstream that are derived from the real-time video bitstream content.

2. Description of the Background Art

In a video-on-demand system such as the OnSet™ system 25 manufactured by DIVA Systems Corporation, a file server is used for streaming video information to users (subscribers) of the system. The OnSet™ system is described in U.S. patent application serial number 08/984,710, filed December 30 3, 1997, and the file server is described in U.S. patents 5,671,377 and 5,581,778. The disclosures of this application and these patents are incorporated herein by reference. The OnSet™ system contains service provider equipment coupled through an information distribution 35 network to subscriber equipment. This system provides subscribers VCR-like controls to enable a subscriber to select information content, for example, a movie, then play, fast forward, rewind, pause, or stop the selected movie. The subscriber enters control commands through the

subscriber equipment and the service provider equipment executes the commands to fulfill the purpose of the command, e.g., play, fast forward, rewind, stop or pause the movie.

A file server forms a portion of the service provider  
5 equipment and stores, for a given movie, a standard play stream (i.e., an MPEG-2 compressed video bitstream), a fast forward stream and a fast reverse play (rewind) stream. The fast forward and fast reverse streams are also MPEG-2 compressed video, where the fast forward stream is a  
10 compressed signal containing only every Nth frame of the uncompressed play video and the fast reverse stream is a compressed signal containing every Nth frame of the uncompressed play video played backwards. To store the video information, each stream is divided into portions  
15 (e.g., N-byte segments of compressed data) and striped onto a disk array. The disk array stores all the information that the file server can directly access.

The process for generating the fast forward and fast reverse streams is performed in a non-real time manner such  
20 that the video content is pre-encoded and stored in the file server. The process requires a frame by frame analysis of the video stream to enable the frames to be encoded in an MPEG-2 compliant form, yet provide a fast forward and fast reverse effect when decoded. As such, the video sequence is  
25 processed to extract every Rth frame (i.e., one of every R frames, where R is an integer greater than 1) to form a fast forward sequence and then the fast forward sequence is encoded (compressed). For a fast reverse stream, a sequence of frames in reverse order is created and encoded. This  
30 encoding process can not be used for producing fast forward and fast reverse streams in real time such that a real time program can be encoded and stored for almost immediate use of VCR-like functions.

Therefore, there is a need in the art for an improved  
35 encoding system for a video-on-demand system to ensure near real-time availability of fast forward and fast reverse functions and real-time availability of a high bit rate

video bitstream that, when decoded, produces a play sequence.

SUMMARY OF THE INVENTION

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The disadvantages associated with the prior art are overcome by the invention of a demand television system that simultaneously encodes a broadcast video frame sequence into a broadcast bitstream and a storage bitstream. The 10 broadcast bitstream is broadcast to system subscribers as the sequence is encoded, while the storage bitstream is stored in an information server. The subscriber may, at any time during the broadcast, elect to review content of the broadcast that was previously displayed. Upon electing to 15 review, the system transmits the storage bitstream to the subscriber in a pointcast manner. The storage bitstream contains, for example, a plurality of selectable types of bitstreams including fast forward, fast reverse and standard play. As such, by requesting particular functions, the 20 subscriber is provided with VCR-like functions for a broadcast program.

To facilitate this functionality, a video encoder that simultaneously produces an MPEG-2 compliant fast forward, fast reverse and play bitstreams from a sequence of video 25 frames, e.g., 601-format video, as well as a real-time bitstream for real-time transmission to the user as a broadcast transmission. The encoder of the present invention contains a broadcast encoder and a storage encoder. The broadcast encoder encodes the video frame 30 sequence using, for example, a high bit rate encoder to ensure accurate encoding and transmission of sporting events. While simultaneously the storage encoder subsamples the video sequence, extracts a plurality of frames from the video sequence and buffers the subsampled frames. 35 Simultaneous with the subsampling and buffering, the storage encoder also encodes the source frames within a real-time encoder, e.g., an MPEG-2 encoder, to form a standard play bitstream for storage within the file server.

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As the play bitstream is being encoded, the buffered frames are recalled from the buffer and coupled to a second real-time encoder. The second encoder forms both the fast forward and fast reverse bitstreams using a time  
5 multiplexing technique wherein a group of pictures (GOP) for the fast forward stream can be formed, followed by the compression of the same GOP having the frames organized in reverse order. As such, the compressed GOPs are represented by the fast forward and fast reverse bitstreams. The play,  
10 fast forward, and fast reverse bitstreams for each GOP are organized into a file and stored on the mass storage device (e.g., disk drive array) of the file server.

While the bitstreams that facilitate the VCR-like functions are being encoded and stored, the high bit rate  
15 encoded signal is broadcast to subscribers. As such, the subscriber may watch an event (e.g., a sporting event) in real-time, then elect to "rewatch" a previously viewed portion of the real-time event. The viewer merely depresses a "rewind" or reverse button on a remote control and the VOD  
20 system accesses the stored event files and "plays" the fast reverse bitstream. As such, the viewer is provided with the sense of a VCR rewind function. At an appropriate location the viewer depresses a "play" button and the stored standard play bitstream is transmitted to the viewer. The viewer may  
25 "catch up" to the real-time event by either depressing a fast forward button or a "real-time" button. The fast forward button causes the stored fast forward bitstream to be transmitted to the viewer to provide a sense of a VCR fast forward mode and, when the fast forward bitstream  
30 exhausts the available data, the system automatically switches back to the real-time bitstream. The "real-time" button causes the system to instantly switch back to the real-time bitstream.

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BRIEF DESCRIPTION OF THE DRAWINGS

The teachings of the present invention can be readily understood by considering the following detailed description 5 in conjunction with the accompanying drawings, in which:

FIG. 1 is a block diagram of a video-on-demand system that operates in accordance with the present invention;

FIG. 2 depicts a block diagram of the encoder of the present invention;

10 FIG. 3 illustrates the method of the present invention used to produce a fast forward bitstream;

FIG. 4 illustrates the method of the present invention used to produce a fast reverse bitstream; and

15 FIG. 5 illustrates the interaction model between the service provider equipment and subscriber equipment.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures.

20 DETAILED DESCRIPTION

FIG. 1 depicts a high level block diagram of the illustrative information distribution system 100 that incorporates the present invention. The system 100 contains 25 service provider equipment 102, a communications network in the form of a cable transport subsystem 104 and subscriber equipment 106<sub>n</sub>, where n is an integer greater than 0. The service provider equipment 102 contains an information server 108 which is typically a parallel processing computer 30 containing at least one central processing unit 110 and associated memory 112. U.S. patent number 5,671,377, issued September 23, 1993 and U.S. patent number 5,579,527, issued November 26, 1996, which are hereby incorporated herein by reference, describe a server that is capable of operating in 35 the capacity of information server 108. The server 108 interacts with the data storage device 114 (e.g., a disk drive array) that generally stores the subscriber information (e.g., video data) that is transmitted directly

to the subscriber equipment 106 as well as recalled and downloaded to the subscriber equipment 106. The video data is produced by an encoder 200 as two streams: the first is a stream containing a real-time bitstream of encoded video 5 information that is to be broadcast to the subscribers (referred to herein as the broadcast stream), the second is a stream containing a non-real-time bitstream of encoded video information that is stored by the information server to facilitate VCR-like functions (referred to herein as the 10 storage stream).

Additionally, within the service provider equipment 102 is a video session manager 122 that provides session control of the information flowing to and from the server 108. The video session manager 122 contains its own central 15 processing unit (CPU) 124 and associated memory 126 that provides functionality for the graphical user interfaces through which the consumer interacts with the system. The CPU 124 is part of a session control manager 125 that controls a plurality of modems 127 that facilitate 20 communication with the subscriber equipment. Other subsystems of the service provider equipment include a network manager 142 and a back office subsystem 144. These subsystems maintain certain databases of information that enable the system to accurately control system access, 25 subscription package definitions, and subscriber/consumer profile and billing.

The information server 108 is coupled to the video session manager 122 via data path 116, synchronization clock path 118, and control path 120. The server 108 provides 30 data streams that are destined for consumers on path 116 and a synchronization clock on path 118. The specific data streams are provided in response to requests for information (e.g., menu applets, video programs, and other content material) from the video session manager 122 on path 120. 35 These data streams are packetized and modulated onto a carrier that is compatible with the transmission requirements of the network 104.

The video session manager 122 accomplishes all of the transmission interface requirements of the system 100 as well as provides graphical user interface support.

Specifically, the video session manager 122 is coupled

5 through the modems 127 to subscriber equipment via a forward information channel 132, a forward command channel 133 and a back channel 134. All three of these channels are supported by the cable transport subsystem 104. The video session manager 122 contains a modulator for modulating the server  
10 data streams onto one or more carrier frequencies for transmission on the forward information channel 132.

Additionally, modems 127 within the video session manager 122 send control information via the forward command channel and receive control information via the back channel.

15 Moreover, a conventional cable television signal source 128  
is optionally coupled to the forward information channel via  
a signal coupler 130. In operation, the video session  
manager 122 responds to requests from the subscriber  
equipment 106 for interactive menus and data streams by  
20 requesting the server 108 to provide such information, then  
communicating that information to the requesting subscriber  
equipment 106. The video session manager 122, as discussed  
below, also ensures that the subscriber equipment 106 is  
authorized to receive the requested information.

25 The cable transport subsystem 104 can be any one of a  
number of conventional broad band communications networks  
that are available such as a fiber optic network, a  
telephone network, existing cable television network and the  
like. For example, if the network is a hybrid fiber-coax  
30 network, the transport technique used in both forward  
channels may be modeled after the moving pictures expert  
group (MPEG) transport protocol for the transmission of  
video data streams. In general, the transport mechanism for  
both the forward channels and transport information to the  
35 subscriber equipment must be able to carry unidirectional,  
asynchronous packetized data such as that defined in the  
MPEG video and audio signal transmission protocol, and the

like. There are a number of such transport protocols available.

The subscriber equipment 106 receives the requested data streams as well as broadcast streams from the forward information channel, demodulates the streams and processes them for display on the display device 140 (e.g., a conventional television). In addition, the terminal 136 accepts commands from a remote control input device 138 or other input device to facilitate consumer interaction with the system. These commands are formatted, compressed, modulated, and transmitted through the network 104 to the video session manager 122. Typically, this transmission is accomplished through the back channel 134. These commands are preferably transmitted through the same network used to transmit information to the subscriber equipment. However, the back channel coupling the subscriber equipment to the server may be a separate network, e.g., a forward information channel through a television cable network and a back channel through a telephone network. The telephone network could also support the forward control channel. The video session manager 122 interprets each command set from the terminal through the back channel and instructs the information server to perform certain functions to implement the consumer/subscriber request.

FIG. 2 depicts a block diagram of the encoder 200 comprising a broadcast encoder 250 and a storage encoder 255. The broadcast encoder compresses a source video sequence in a conventional manner, i.e., compressing the source video sequence in real-time as the frames are input to the encoder. For example, this encoder may be a high speed encoder such as an 8 Mbps MPEG-2 encoder that accurately encodes such difficult to compress programming such as sporting events.

The storage encoder 252 comprises a first encoder 202, frame subsampler 204, a frame buffer 206, a second encoder 208 and a controller 210. The first encoder 202 encodes a source video sequence in a conventional manner, i.e., compressing the source video sequence in real-time as the

frames are input to the encoder. The second encoder 208 operating in conjunction with the subsampler 204 and the buffer 206 encodes a subsampled version of the source video sequence to form a fast forward and fast reverse bitstreams 5 (collectively referred to herein as trick play bitstreams or trick play streams). The first encoder (the play stream encoder 202) contains a real-time MPEG-2 encoder that produces an MPEG-2 compliant, compressed video bitstream (a play stream) from a sequence of 601-format video frames.

10 The second encoder (the trick play stream encoder 204) is also an MPEG-2 real-time encoder 212.

For the following discussion, frame numbering is used to describe the temporal order in which frames occur in source material where 1 is the first frame in the source 15 material frame sequence and 2 is the second frame and so on. For the following description, R is an integer and defines a play-back speed multiplier which has significance in the trick play processes. The speed multiplier R is a variable that is established by the controller 210. Throughout this 20 disclosure, the exemplary trick play streams are fast forward and fast reverse. Of course other forms of trick play streams may be generated using the encoder 200 of the present invention. If the multiplier R equals 2, playback (decoding) of a fast forward stream is twice normal single 25 speed. If R equals 3, playback is three times normal play speed and so on. Generally, the trick play streams include a nine times fast forward stream and a nine times fast reverse stream. Alternatively, 32 times normal fast forward and fast reverse streams are also available. The term 30 source is used to describe the uncompressed video material (601-format video) from which fast forward and fast reverse bitstreams are generated.

Using the encoder 200, a fast forward MPEG video bitstream is generated from an uncompressed video source 35 such that when the stream is played back linearly through a standard MPEG compliant video decoder, the resulting imagery contains every Rth frame of the original video sequence. As such, the display of the sequence has a fast forward effect.

A fast reverse stream is simultaneously produced by the storage encoder 252 such that when linearly played back through a an MPEG compliant video decoder, the decoded stream produces a sequence of frames that play in reverse 5 relative to the original frame sequence.

The play bitstream is formed using a conventional MPEG-compliant encoder 202 that compresses a plurality of frames (N frames that form a group-of-pictures (GOP)). To form the trick play streams having N frame GOPs, the 10 subsampler 204 extracts one out of every R consecutive frames (arranged in increasing time code order) from the source sequence. The selected N frames are buffered in the frame buffer 206. For example, if R is two and the buffer stores N frames, the buffer stores frames 1, 3, 5, 7, 9, and 15 so on up to frame  $2N+1$ . The buffer 206 stores N successive frames that define a GOP for the trick play bitstreams.

To produce a fast forward stream, the N frames from the buffer 206 are recalled under the control of the controller 210 and coupled sequentially into the real-time encoder 208. 20 The output is a compressed bitstream representing a fast forward GOP.

To produce a fast reverse stream, the N frames from the buffer 206 are recalled under the control of the controller 210 and are coupled in reverse time order into the encoder 25 208. Although two encoders could be used to produce each of the trick play streams independently, as long as R equals two or more, a single encoder can be used to produce both trick play tracks using time multiplexing technique. To perform the multiplexed encoding, the fast forward GOP is 30 encoded first, then the fast reverse GOP. After the buffer is filled with another N frames, the GOP pair is again encoded and so on. The recall order of the frames from the buffer and the multiplexing process are controlled by controller 110 by addressing the buffer in forward order for 35 the fast forward GOP and in reverse order for the fast reverse GOP.

The forward and reverse GOPs contain sequence start and sequence end codes such that, when stored in a mass storage

device along with the standard play stream, the bitstreams are clearly delimited.

The forward and reverse GOP bitstreams are stored with the play stream in a storage medium such as a disk drive array or magneto-optical disk. The fast forward stream is written sequentially, one GOP bitstream at a time, from the lowest address to the highest address. The reverse bitstream is stored in reverse order from highest address to lowest address. The last byte in the reverse GOP is placed in the highest address space of the reverse target file. As such, the reverse GOP precedes, in address space, the first frame of the immediately previously written reverse GOP.

The entire source material frame sequence is encoded in this manner to simultaneously produce a play, a fast forward, and fast reverse streams in real-time.

FIG. 3 illustrates the process by which a fast forward stream is produced. Sequence 300 represents the RN frames that have been subsampled from a video frame sequence at a one of R rate from a video frame sequence and stored in the buffer (e.g., R=2, then 2N frames are subsampled to form a trick play GOP). The integer N is the number of frames that are encoded into each GOP of the standard play stream.

These buffered frames are recalled from memory, encoded and then associated with a normal play stream having a GOP of N frames. The encoder (at step 302) repetitively produces a sequence of GOPs 304 that are stored in increasing addresses in memory as illustrated in sequence 306. The first GOP (GOP 0) contains frames 1 to RN+1, the second GOP (GOP 1) contains frames R(N+1)+1 through 2RN+1, the third GOP (GOP 2) contains frames 2R(N+1)+1 through 3RN+1, and so on. To generalize, a GOP contains frames GR(N+1)+1 through (G+1)RN+1, where G is the GOP number (e.g., 0, 1, 2, 3, ...), R is the subsampling rate, and N is the number of frames in a standard play GOP.

FIG. 4 illustrates the process by which a fast reverse stream is produced. Sequence 400 represents the RN frames that have been buffered after subsampling at one of R rate (e.g., R=2 in FIG. 4). At step 402, these frames are

selected from the buffer in reverse order as illustrated at 404. The reverse order frames are encoded, at step 406, to produce a sequence of GOPs 408 that are stored in reverse time order in memory as illustrated in sequence 410.

5       Returning to FIG. 2, the real-time broadcast encoder 250 is, for example, a high data rate encoder (e.g., producing an 8 Mbps data rate MPEG bitstream) from a real-time television broadcast. The source video is, for example, a television feed of a sporting event. The source 10 video either arrives at the encoder in a frame-based digital video format, such as 601 video, or is converted from some other format into a frame-based video format prior to the encoder. The real-time broadcast encoder operates simultaneously with the storage encoder such that the real- 15 time broadcast bitstream is coupled to the transmission system as the storage bitstreams are being stored in the information server's data storage.

      Returning to FIG. 1 and simultaneously referring to the flow diagram 500 of FIG. 5, The source video is encoded as a 20 broadcast stream in step 502 and as a storage stream in step 504. As described above, the storage bitstream is stored in the information server memory at step 506, while the broadcast bitstream is transmitted to the subscribers at step 508. To facilitate broadcast of the broadcast 25 bitstream, the broadcast bitstream is coupled into path 116 to the video session manager 122. The video session manager 122 multiplexes the broadcast bitstream into a transport stream along with all the other multimedia signals, control signals and the like that are transmitted through the cable 30 transport subsystem 104 to the subscriber equipment 106. At step 510, the subscriber terminal 136 demodulates, demultiplexes and decodes the broadcast bitstream for real-time display.

      To facilitate VCR-like functions with respect to the 35 broadcast bitstream, the subscriber terminal 136 can request the stored bitstreams corresponding to the broadcast bitstream by manipulating the input device 138 (step 512) in the same manner as the device is used to control the display

of any other video asset. The subscriber, at any time, may elect to review a portion of the program that has already been watched. As such, the subscriber manipulates the input device 138 (step 512) such that, at step 514, a "rewind" or 5 fast reverse command is sent from the subscriber terminal 136 to a modem 127 requesting rewind. The session control manager 125 then instructs, at step 516, the information server 108 to recall the fast reverse stream associated with the broadcast bitstream and send, at step 518, the fast 10 reverse stream to the requesting subscriber, i.e., the transmission to the subscriber is now changed from a broadcast transmission to a pointcast transmission. At step 520, the subscriber terminal demodulates, demultiplexes and decodes the transport stream carrying the reverse play 15 stream such that the display 140 depicts the broadcast video running quickly backwards at some rewind rate, e.g., nine times standard play.

At some point during the "rewinding" of the video sequence, the subscriber may, at step 522, elect to "play" 20 the video sequence. By selecting the "play" button on the input device, the subscriber terminal sends, at step 524, a request to the session control manager 125. The session control manager 125 then requests, at step 526, the standard play stream to be sent, at step 528, to the subscriber 25 starting at the location at which the video sequence had been "rewound", i.e., whatever frame number the subscriber was viewing at the time the play button was depressed will be the starting frame number that is sent to the subscriber in the play stream. At step 530, the play stream is then 30 demodulated, demultiplexed, and decoded such that the display in the subscriber's home transitions from rewind to play. The subscriber may then watch the program from this point forward or may request another trick play function.

For example, at step 532, the subscriber selects a fast 35 forward function to move through the video quickly, e.g., nine times standard play speed. If the subscriber elects to fast forward through the video, the subscriber terminal once again sends, at step 534, a request to the session control

manager 125 which, in turn, requests, at step 536, the information server to recall the fast forward stream starting at the frame (or near the frame) that the user was then watching in the play stream. The session control 5 manager 125 sends, at step 538, the fast forward stream to the subscriber. At step 540, the fast forward stream is then demodulated, demultiplexed and decoded to present a fast forward display. This stream will be transmitted until there is no longer any fast forward data, i.e., the storage 10 bitstream catches up with the broadcast stream and an end of file (EOF) indicator is reached. At that occurrence, the subscriber terminal, at step 542, automatically switches the subscriber back to the broadcast stream. At step 544, the subscriber terminal 136, demodulates, demultiplexes and 15 decodes the broadcast stream.

An alternative to requiring the subscriber to fast forward to catch up to the broadcast stream is to provide a "catch up" button that, when depressed, causes the subscriber terminal to instantly transition from decoding 20 the storage bitstream to decoding the broadcast bitstream. This button may be a hardware button on the input device or a software button that is displayed on the television display.

Although various embodiments which incorporate the 25 teachings of the present invention have been shown and described in detail herein, those skilled in the art can readily devise many other varied embodiments that still incorporate these teachings.

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What is claimed is:

1. Apparatus for providing demand television comprising:
  - a broadcast encoder for encoding a video frame sequence
  - 5 to form a broadcast bitstream;
  - a storage encoder for encoding the video frame sequence
  - to form a storage bitstream;
  - a transmission system for transmitting the broadcast
  - bitstream to subscriber equipment;
  - 10 a storage device for storing the storage bitstream; and
  - wherein the storage device stores the storage bitstream
  - at the same time that the transmission system transmits the
  - broadcast bitstream.
- 15 2. The apparatus of claim 1 wherein said broadcast encoder
- is a high data rate encoder.
3. The apparatus of claim 1 wherein said video frame
- sequence is a real-time video frame sequence.
- 20 4. The apparatus of claim 1 wherein said storage bitstream
- contains play and trick play bitstreams.
5. The apparatus of claim 1 wherein said storage encoder
- 25 comprises:
  - a first encoder for producing a first bitstream that
  - contains information that, when decoded, produces a standard
  - forward play video frame sequence;
  - a frame subsampler;
  - 30 a buffer that stores subsampled frames of the video
  - sequence;
  - a second encoder for producing a second bitstream that
  - contains information that, when decoded, produces a fast
  - forward video frame sequence;
  - 35 a third encoder for producing a third bitstream that
  - contains information that, when decoded, produces a fast
  - reverse video frame sequence; and

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a controller that selects subsampled frames from the buffer and couples to selected frames to the second and third encoders.

5 6. The apparatus of claim 5 wherein said first encoder is an MPEG encoder that encodes N frames of the video sequence.

7. The apparatus of claim 6 wherein said second and third encoders are MPEG encoders that encodes N subsampled frames.

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8. The apparatus of claim 5 wherein the controller multiplexes selection of the frames from the buffer to apply a plurality of subsampled frames to said second encoder to form said second bitstream and then apply a plurality of 15 subsampled frames to said third encoder to form said third bitstream.

9. A method for providing demand television comprising the steps of:

20 encoding, in real-time, a broadcast video frame sequence to form a broadcast bitstream, while at the same time encoding the broadcast video frame sequence to form a storage bitstream;

broadcasting the broadcast bitstream to subscriber 25 equipment;

storing the storage bitstream within a storage device; upon a subscriber selecting to view information previously broadcast by the broadcast bitstream, transmitting to the subscriber the storage bitstream.

30

10. The method of claim 9 wherein said broadcast bitstream is a high data rate bitstream.

35 11. The method of claim 9 wherein the storage bitstream contains a play bitstream and a trick play bitstream.

12. The method of claim 9 wherein said storage bitstream encoding step comprises the steps of:

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encoding said frames to form a first bitstream;  
subsampling said broadcast video frames;  
buffering said subsampled frames;  
recalling said buffered frames in a forward time  
5 sequence order;  
encoding said recalled buffered frames to form a second  
bitstream;  
recalling said buffered frames in a reverse time  
sequence order;  
10 encoding said recalled buffered frames to form a third  
bitstream.

13. The method of claim 12 wherein said first bitstream  
when decoded forms a standard play frame sequence.

15 14. The method of claim 12 wherein said second bitstream,  
when decoded, forms a fast forward frame sequence.

20 15. The method of claim 12 wherein said third bitstream,  
when decoded, forms a fast reverse frame sequence.

16. The method of claim 9 wherein said storage bitstream  
contains a plurality of bitstream types and said storage  
bitstream transmitting step further comprises the steps of:

25 recalling from said storage device a particular  
bitstream in response to a request for a particular  
bitstream type from a subscriber terminal;  
addressing the requested bitstream to said requesting  
subscriber;  
30 transmitting said requested bitstream to said  
subscriber equipment.

17. The method of claim 16 wherein said storage bitstream  
types include a play bitstream, a fast forward bitstream and  
35 a fast reverse bitstream.

18. The method of claim 17 wherein said fast forward  
bitstream contains an indicator that delimits the end of

DETAILED DESCRIPTION

available data and the method further comprises a step of switching from transmitting a fast forward bitstream to transmitting said broadcast bitstream upon reaching the indicator.

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19. The method of claim 9 further comprising the step of: upon a request from a subscriber, switching from decoding said storage bitstream to decoding said broadcast bitstream.

10

20. A method of providing demand television comprising the steps of:

transmitting a broadcast bitstream to a plurality of subscriber equipment;

15 storing said broadcast bitstream as a storage bitstream while said broadcast bitstream is being transmitted;

decoding, within subscriber equipment, said video bitstream; and

upon said subscriber equipment requesting said storage  
20 bitstream to enable review of information contained in said broadcast bitstream, transmitting said storage bitstream to said subscriber having requested the storage bitstream.

21. The method of claim 20 wherein said storage bitstream  
25 comprises a play bitstream and a trick play bitstream.

22. The method of claim 21 wherein said trick play bitstream comprises a fast forward bitstream and a fast reverse bitstream.

30

23. The method of claim 22 further comprising the step of: upon said fast forward bitstream being exhausted of data, automatically switching from said storage bitstream to said broadcast bitstream.

24. The method of claim 20 further comprising the step of:  
upon said subscriber equipment requesting said  
broadcast bitstream, switching from said storage bitstream  
5 to said broadcast bitstream.

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Abstract of the Disclosure

A demand television system comprising a broadcast encoder and a storage encoder. The broadcast encoder encodes a real-time video frame sequence to form a broadcast bitstream and broadcasts the broadcast bitstream to a plurality of subscriber equipment, while simultaneously the storage encoder encodes the real-time video frame sequence to form a storage bitstream that is stored in an information server. The subscriber equipment decodes the broadcast bitstream to display the broadcast program. At any time, the subscriber equipment may request to review the information previously displayed in the broadcast bitstream.

As such, the storage bitstream is transmitted to the subscriber equipment. The storage bitstream facilitates standard play of the previously broadcast information as well as trick play such as fast forward and fast reverse functions.

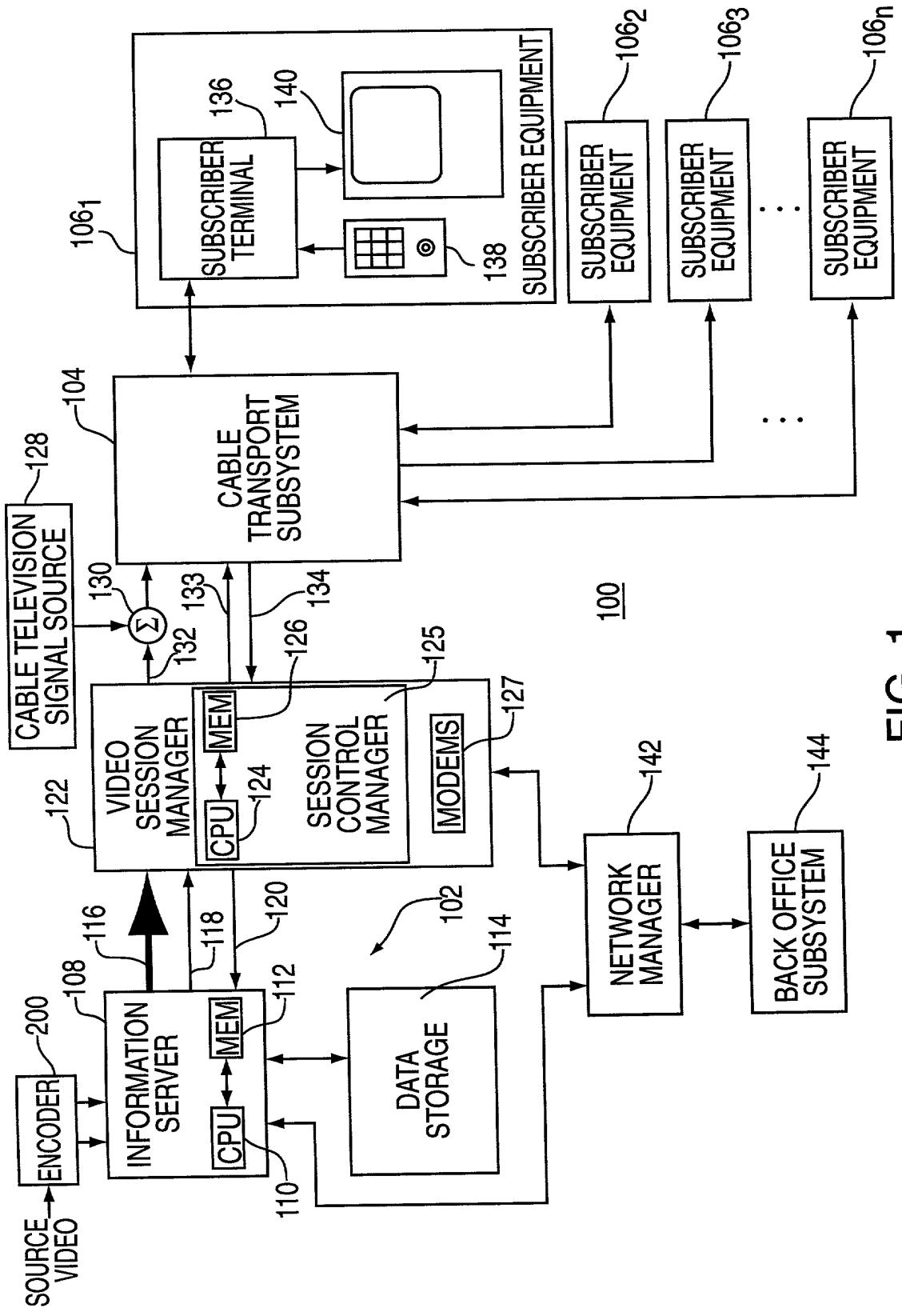
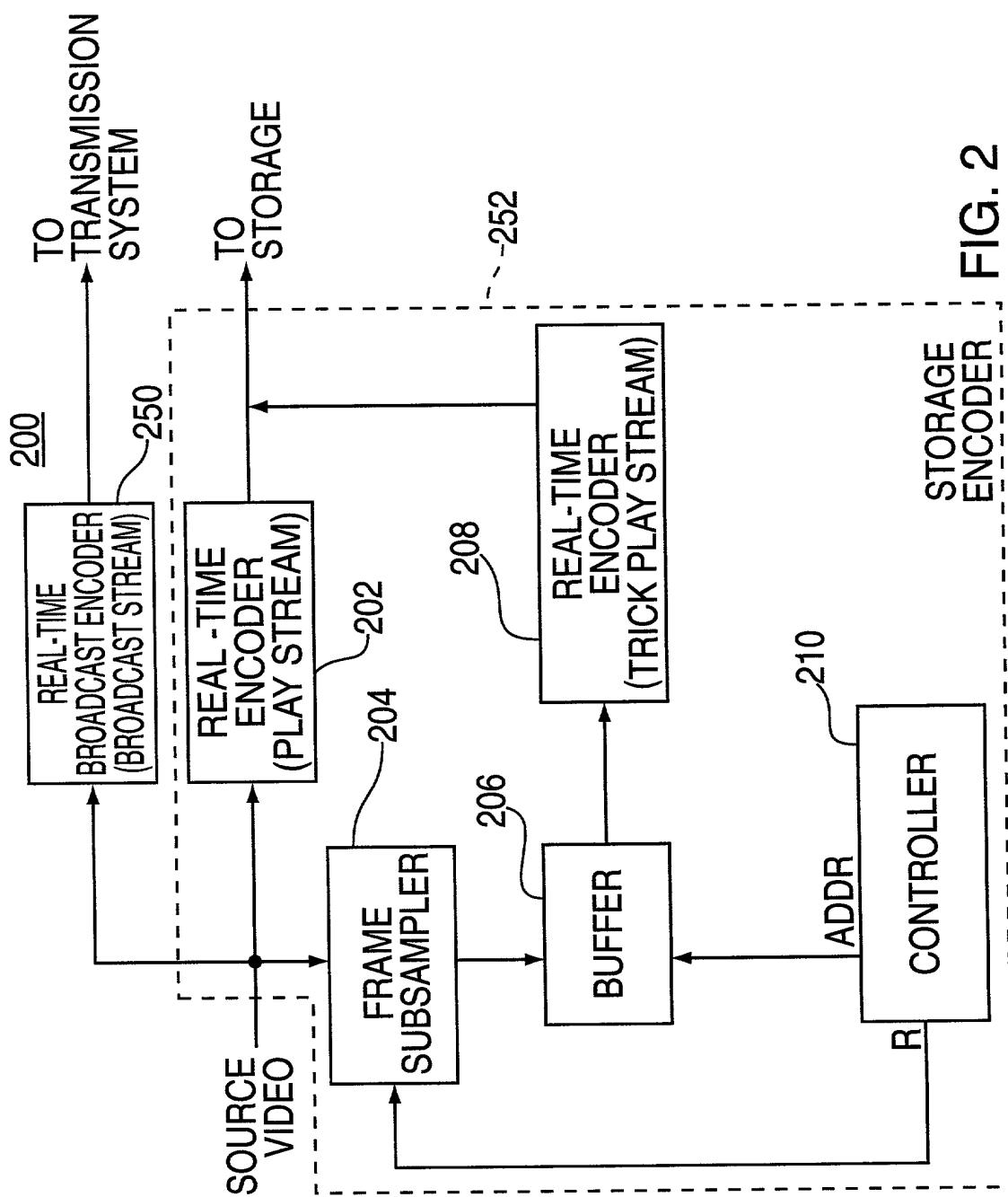


FIG. 1



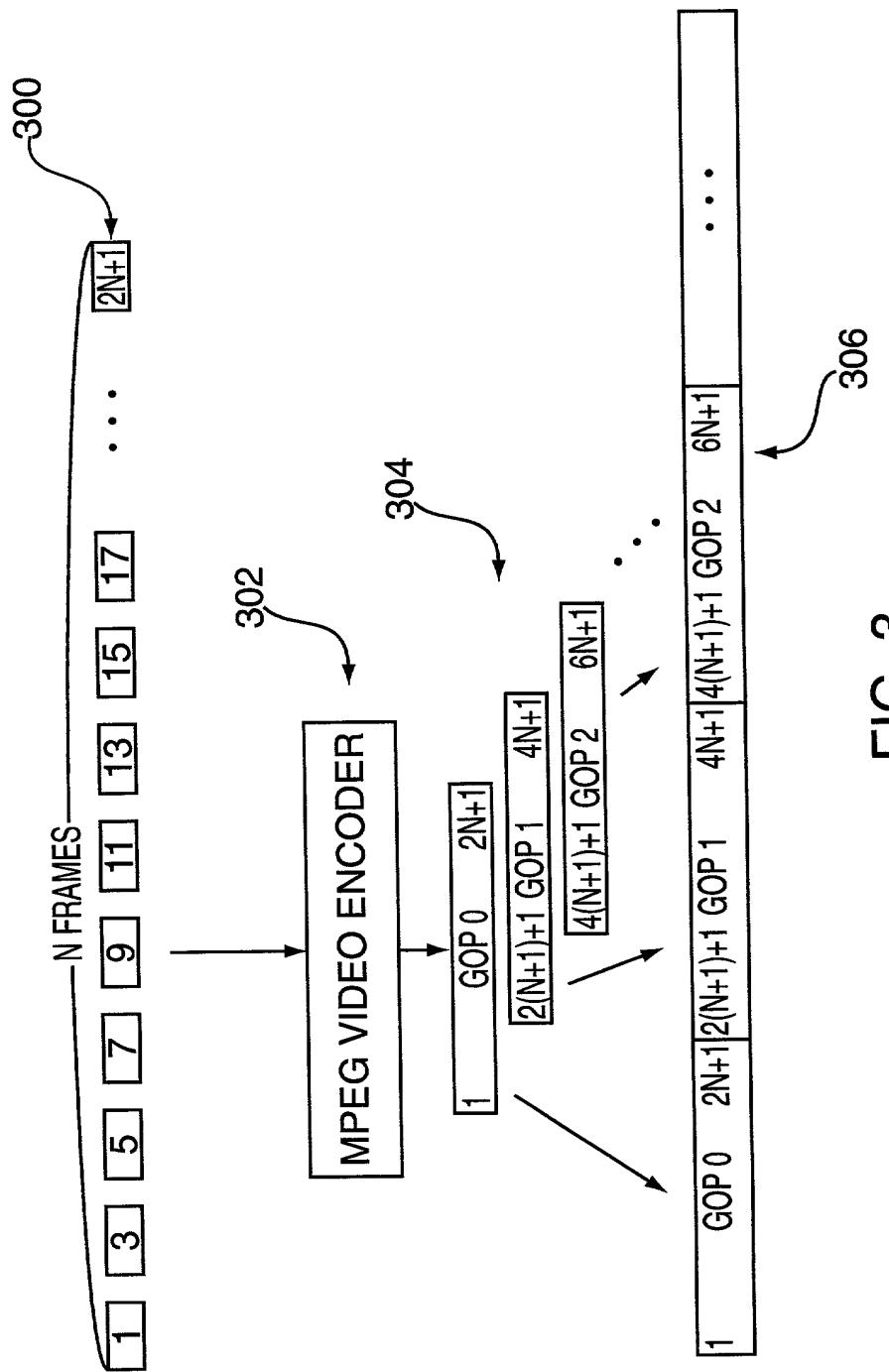


FIG. 3

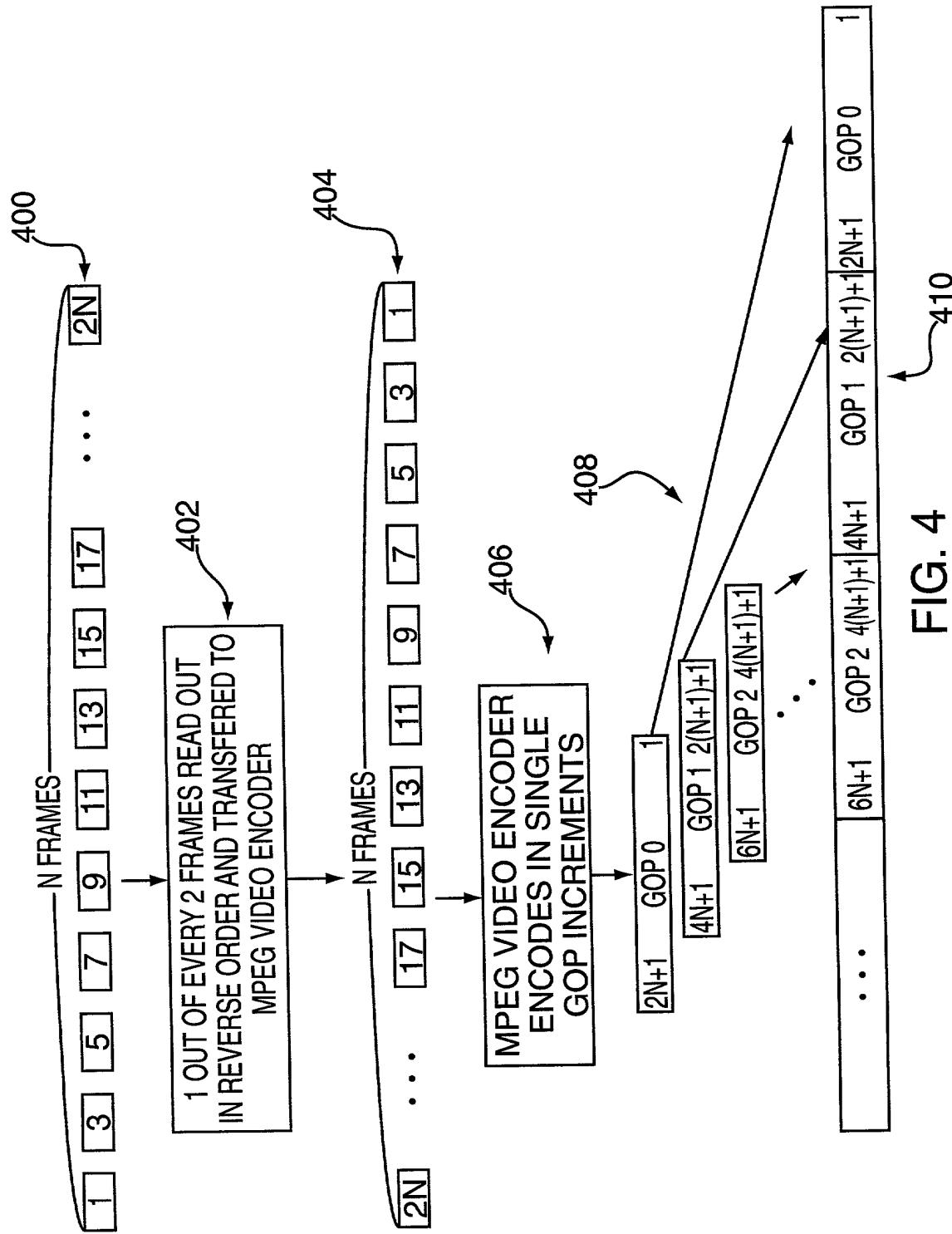


FIG. 4

## SERVICE PROVIDER EQUIPMENT      SUBSCRIBER EQUIPMENT

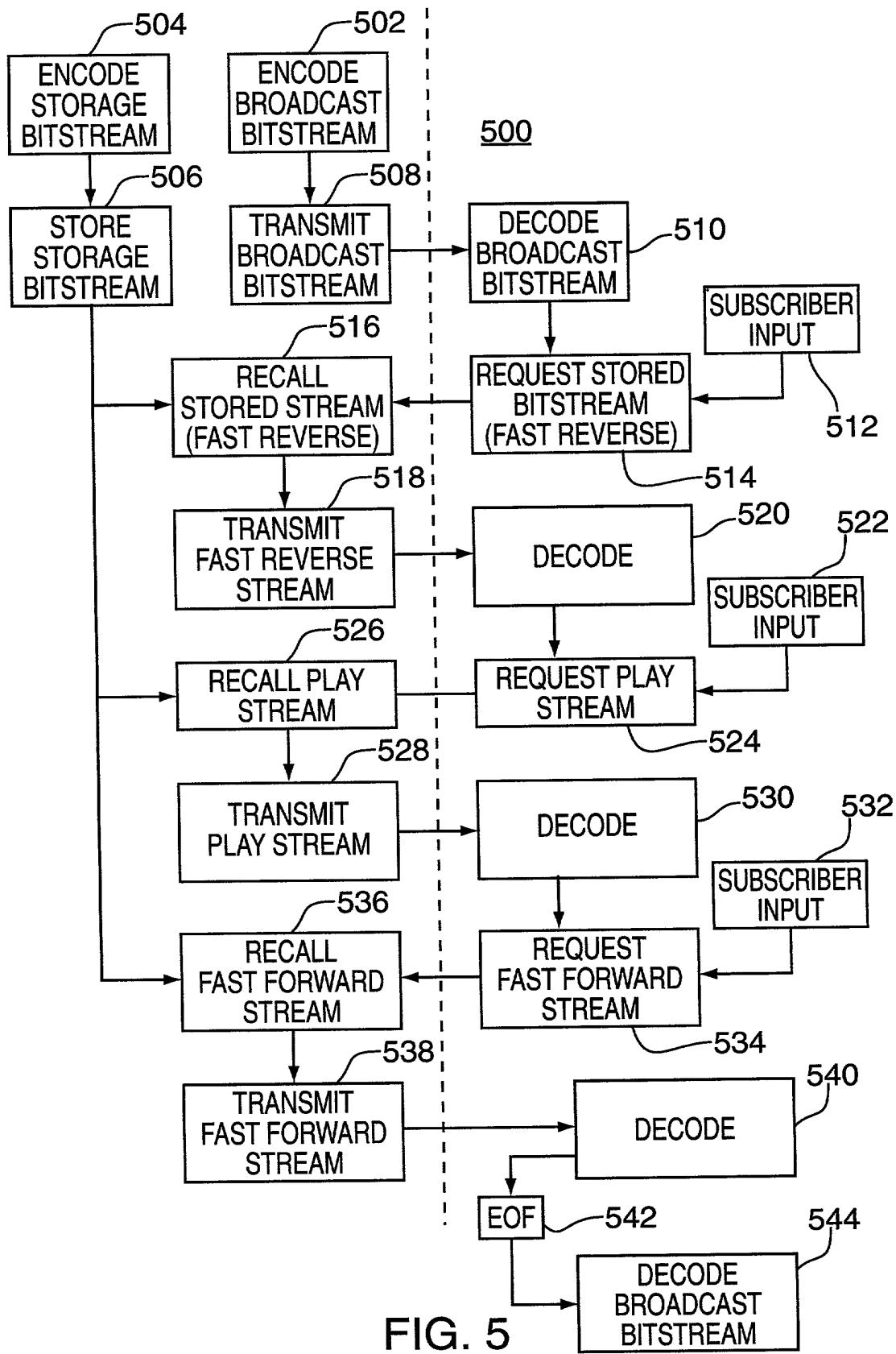


FIG. 5

## COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

This declaration is of the following type:

- original
- divisional
- continuation
- continuation-in-part

### INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

### TITLE OF INVENTION

METHOD AND APPARATUS FOR PRODUCING DEMAND REAL-TIME TELEVISION

### SPECIFICATION IDENTIFICATION

The specification of which:

- is attached hereto
- was filed on \_\_\_\_\_, under Serial No. \_\_\_\_\_, executed on even date herewith; or
  - Express Mail No. \_\_\_\_\_ (as Serial No. not yet known)
- and was amended on \_\_\_\_\_ (if applicable)
- was described and claimed in PCT International Application No. \_\_\_\_\_ filed on \_\_\_\_\_ and as amended under PCT Article 19 on \_\_\_\_\_.

### ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information I know to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56, and which is material to the examination of this application; namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and

- In compliance with this duty, there is attached an Information Disclosure Statement in accordance with 37 CFR §1.98.

### PRIORITY CLAIM (35 U.S.C. §119)

I hereby claim priority benefits under Title 35, United States Code, §119, of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America or of any United States Provisional Application(s) listed below, and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one

country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

- No such applications have been filed.  
 Such applications have been filed as follows:

A. Prior foreign/PCT/provisional application(s) filed within 12 mos. (6 mos. for design) prior to this application, and any priority claims under 35 U.S.C. §119

<u>Country/PCT</u>	<u>Application No.</u>	<u>Date Filed</u>	<u>Priority Claimed</u>
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

B. All foreign application(s), if any, filed more than 12 mos. (6 mos for design) prior to this U.S. application

Country:

Application No:

Filing date:

**PRIOR U.S. APPLICATION(S) FOR WHICH BENEFIT  
UNDER 35 U.S.C. §120 IS CLAIMED**

<u>Serial No.</u>	<u>Filing Date</u>	<u>Status</u>		
		<u>Patented</u>	<u>Pending</u>	<u>Abandoned</u>
		<input type="checkbox"/> patented	<input type="checkbox"/> pending	<input type="checkbox"/> abandoned
		<input type="checkbox"/> patented	<input type="checkbox"/> pending	<input type="checkbox"/> abandoned
		<input type="checkbox"/> patented	<input type="checkbox"/> pending	<input type="checkbox"/> abandoned

**POWER OF ATTORNEY**

I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

Charles Lee Thomason	Registration No. 31,431
Raymond R. Moser Jr.	Registration No. 34,682
Joseph Pagnotta	Registration No. 39,322
Kin-Wah Tong	Registration No. 39,400
Eamon J. Wall	Registration No. 39,414

**Send correspondence to:**                            **Direct telephone calls to:**

Thomason & Moser The Galleria -- 2d Floor 2-40 Bridge Ave. Post Office Box 8160 Red Bank, NJ 07701	Raymond R. Moser Jr. 732-530-9404
--	--------------------------------------

**DECLARATION**

*I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and, further, that these*

statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Sec. 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

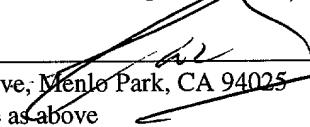
Full name of sole or first inventor: Donald F. Gordon

Inventor's signature:   
Residence: 170 Formway Ct., Los Altos, CA 94022  
Post Office Address: same as above

Date: 11/24/98

Country of Citizenship: U.S.A.

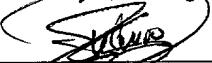
Full name of second inventor: Christopher Goode

Inventor's signature:   
Residence: 722 Creek Drive, Menlo Park, CA 94025  
Post Office Address: same as above

Date: 11/24/98

Country of Citizenship: Australia

Full name of third inventor: Ted Ludvig

Inventor's signature:   
Residence: 831 Canyon Road, Redwood City, CA 94062  
Post Office Address: same as above

Date: 11/24/98

Country of Citizenship: Canada

Full name of fourth inventor:

Inventor's signature: \_\_\_\_\_ Date: \_\_\_\_\_  
Residence:  
Post Office Address:

Country of Citizenship:

Full name of fifth inventor:

Inventor's signature: \_\_\_\_\_ Date: \_\_\_\_\_  
Residence:  
Post Office Address:

Country of Citizenship:

Full name of sixth inventor:

Inventor's signature: \_\_\_\_\_ Date: \_\_\_\_\_  
Residence:  
Post Office Address:

Country of Citizenship:

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY  
STATUS (37 CFR 1.9(f) AND 1.27 (c)) - SMALL BUSINESS CONCERN**

Docket No.  
533/173

Serial No.

Filing Date

Patent No.

Issue Date

Applicant/ **Donald F. Gordon, Christopher Goode, *EDWARD A.*, Ted Ludvig**  
Patentee:

Invention: **METHOD AND APPARATUS FOR PRODUCING DEMAND REAL-TIME TELEVISION**

I hereby declare that I am:

- the owner of the small business concern identified below:
- an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: **DIVA Systems Corporation**

ADDRESS OF CONCERN: **333 Ravenswood Avenue, Menlo Park, CA 94025**

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the above identified invention described in:

- the specification filed herewith with title as listed above.
- the application identified above.
- the patent identified above.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed on the next page and no rights to the invention are held by any person, other than the inventor, who could not qualify as an independent inventor under 37 CFR 1.9(c) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- no such person, concern or organization exists.
- each such person, concern or organization is listed below.

FULL NAME

---

ADDRESS

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Individual

Small Business Concern

Nonprofit Organization

FULL NAME

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ADDRESS

---

Individual

Small Business Concern

Nonprofit Organization

FULL NAME

---

ADDRESS

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Individual

Small Business Concern

Nonprofit Organization

FULL NAME

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ADDRESS

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Individual

Small Business Concern

Nonprofit Organization

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING:

Stephanie Storms

---

TITLE OF PERSON SIGNING

---

Vice President

---

OTHER THAN OWNER:

---

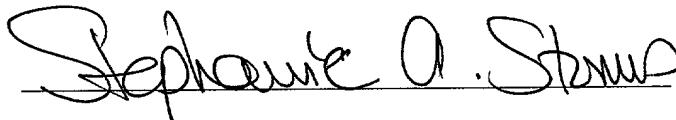
ADDRESS OF PERSON SIGNING:

DIVA Systems Corporation

333 Ravenswood Avenue

Menlo Park, California 94025

SIGNATURE:



DATE: 11/24/98